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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Thomas Andrew Strasser et al.

Serial No.: 10/099,890

Filed: 03/15/02

Title: METHOD AND APPARATUS FOR INTERCONNECTING A PLURALITY OF OPTICAL TRANSDUCERS WITH A WAVELENGTH DIVISION MULTIPLEXED OPTICAL SWITCH

Art Unit: 2633

Examiner: Unassigned

Docket No.: PH01-00-04C

Assistant Commissioner for Patents
Box Missing Parts
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

In regard to the above-identified application, please enter the following preliminary amendment and remarks:

IN THE SPECIFICATION

Please amend the specification as follows:

Please replace paragraphs **0034, 0043, 0044, and 0045** with the following rewritten paragraphs:

[0034] More flexible still are all-optical reconfigurable switches which have much lower insertion losses and are less expensive than the aforementioned OXC's. Various examples of all-optical reconfigurable optical switches are disclosed in U.S. Patent Application Serial No. 09/571,833, which is hereby incorporated by reference in its entirety, and in particular FIGs. 2-4 of that reference. The switching elements disclosed therein can selectively direct any wavelength component from any input port to any output port, independent of the routing of the other wavelengths without the need for any electrical-to-optical conversion. Another all-optical reconfigurable optical switch that provides additional functionality is disclosed in U.S. Patent Application Serial No. 09/691,812, which is hereby incorporated by reference in its entirety. This reference discloses an optical switching element in which each and every wavelength component can be directed from any given port to any other port without constraint. More specifically, unlike most optical switches, this switch is not limited to providing connections between a subset of input ports and a subset of output ports, or vice versa. Rather, this switch can also provide a connection between two ports within the same subset (either input or output). While the present invention may employ any of the aforementioned reconfigurable optical switches, the optical switch disclosed in U.S. Patent Application Serial No. 09/691,812 will serve as an exemplary reconfigurable optical switch, and accordingly, additional details concerning this switch will be presented below.

[0043] As previously mentioned, for purposes of illustration only the present invention will be depicted in connection with the reconfigurable optical switch disclosed in the aforementioned U.S. Apple. Serial No. 09/691,812, which is shown in FIG. 3. Of course, those of ordinary skill in the art will recognize that the invention is equally applicable to a communication system that employs any reconfigurable optical switch in which any wavelength component received on any input port can be selectively directed to any output port, independent of the routing of the other wavelengths. In FIG. 3, the optical switch 300 comprises an optically transparent substrate 308, a plurality of dielectric thin film filters 301, 302, 303, and 304, a plurality of collimating lens pairs 321, 322, 323, and 324, a plurality of tiltable mirrors 315, 316,

317, and 318 and a plurality of output ports 340_1, 340_2, ... 340_n. A first filter array is composed of thin film filters 301 and 303 and a second filter array is composed of thin film filters 302 and 304. Individual ones of the collimating lens pairs 321-324 and tiltable mirrors 315-318 are associated with each of the thin film filters. Each thin film filter, along with its associated collimating lens pair and tiltable mirror effectively forms a narrow band, free space switch, i.e. a switch that routes individual wavelength components along different paths. The tiltable mirrors are micro mirrors such as the MEMS (microelectromechanical systems) mirrors. Alternatively, other mechanisms may be employed to control the position of the mirrors, such as piezoelectric actuators, for example.

[0044] In operation, a WDM optical signal composed of different wavelengths λ_1, λ_2, λ_3 and λ_4 is directed from the optical input port 340 to a collimator lens 314. The WDM signal traverses substrate 308 and is received by thin film filter 301. According to the characteristics of the thin film filter 301, the optical component with wavelength λ_1 is transmitted through the thin film filter 301, while the other wavelength components are reflected and directed to thin film filter 302 via substrate 308. The wavelength component λ_1, which is transmitted through the thin film filter 301, is converged by the collimating lens 321 onto the tiltable mirror 315. Tiltable mirror 315 is positioned so that wavelength component λ_1 is reflected from the mirror to a selected one of the output ports 340_1-340_n via thin film filters 302-304, which all reflect wavelength component λ_1. The particular output port that is selected to receive the wavelength component will determine the particular orientation of the mirror 315.

[0045] As mentioned, the remaining wavelength components λ_2, λ_3, and λ_4 are reflected by thin film filter 301 through lens 321 back into substrate 308 and directed to thin film filter 302. Wavelength component λ_2 is transmitted through thin film filter 302 and lens 322 and directed to a selected output port by tiltable mirror 316 via thin film filters 303-304, which all reflect wavelength component λ_2. Similarly, all other wavelength components are separated in sequence by the thin film filters 303-304 and subsequently directed by tiltable mirrors 317-318 to selected output ports. By appropriate actuation of the tiltable mirrors, each wavelength

component can be directed to an output port that is selected independently of all other wavelength components.

STATUS OF CLAIMS

Claims 1-65 are pending.

REMARKS

This is a preliminary amendment before the first Office Action.

Claims 1-65 are pending herein.

The specification is amended to include the previously unknown serial numbers and filing dates of two related co-pending patent applications, and to correct inadvertent typographical errors made in certain reference numbers so that these reference numbers correctly correspond to the reference numbers used in the drawings.

Attached hereto is a marked-up version of the changes made to the specification by this preliminary amendment. The attached page is captioned **"Version with markings to show changes made"**.

CONCLUSION

Applicant submits Claims 1-65 are in condition for examination, early notification of which is earnestly solicited. Should the Examiner be of the view that an interview would expedite consideration of this Amendment or of the application at large, request is made that the Examiner telephone the Applicant's attorney at (908) 518-7700 in order that any outstanding issues be resolved.

FEES

If there are any fees due and owing in respect to this amendment, the Examiner is authorized to charge such fees to deposit account number 50-1047.

Respectfully submitted,

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Version with markings to show changes made

In the specification:

[0034] More flexible still are all-optical reconfigurable switches which have much lower insertion losses and are less expensive than the aforementioned OXC's. Various examples of all-optical reconfigurable optical switches are disclosed in U.S. Patent Application Serial No. [[PH-01-00-01]] 09/571,833, which is hereby incorporated by reference in its entirety, and in particular FIGs. 2-4 of that reference. The switching elements disclosed therein can selectively direct any wavelength component from any input port to any output port, independent of the routing of the other wavelengths without the need for any electrical-to-optical conversion. Another all-optical reconfigurable optical switch that provides additional functionality is disclosed in U.S. Patent Application Serial No. [[PH-01-00-02]] 09/691,812, which is hereby incorporated by reference in its entirety. This reference discloses an optical switching element in which each and every wavelength component can be directed from any given port to any other port without constraint. More specifically, unlike most optical switches, this switch is not limited to providing connections between a subset of input ports and a subset of output ports, or vice versa. Rather, this switch can also provide a connection between two ports within the same subset (either input or output). While the present invention may employ any of the aforementioned reconfigurable optical switches, the optical switch disclosed in U.S. Patent Application Serial No. [[PH01-00-02]] 09/691,812 will serve as an exemplary reconfigurable optical switch, and accordingly, additional details concerning this switch will be presented below.

[0043] As previously mentioned, for purposes of illustration only the present invention will be depicted in connection with the reconfigurable optical switch disclosed in the aforementioned U.S. Apple. Serial No. [[PH01-00-02]] 09/691,812, which is shown in FIG. 3. Of course, those of ordinary skill in the art will recognize that the invention is equally applicable to a communication system that employs any reconfigurable optical switch in which any wavelength component received on any input port can be selectively directed to any output port, independent

of the routing of the other wavelengths. In FIG. 3, the optical switch 300 comprises an optically transparent substrate 308, a plurality of dielectric thin film filters 301, 302, 303, and 304, a plurality of collimating lens pairs [321_1 and 321_2, 322_1 and 322_2, 323_1 and 323_2, 324_1 and 324_2] 321, 322, 323, and 324, a plurality of tiltable mirrors 315, 316, 317, and 318 and a plurality of output ports 340_1, 340_2, ... 340_n. A first filter array is composed of thin film filters 301 and 303 and a second filter array is composed of thin film filters 302 and 304. Individual ones of the collimating lens pairs 321-324 and tiltable mirrors 315-318 are associated with each of the thin film filters. Each thin film filter, along with its associated collimating lens pair and tiltable mirror effectively forms a narrow band, free space switch, i.e. a switch that routes individual wavelength components along different paths. The tiltable mirrors are micro mirrors such as the MEMS (microelectromechanical systems) mirrors. Alternatively, other mechanisms may be employed to control the position of the mirrors, such as piezoelectric actuators, for example.

[0044] In operation, a WDM optical signal composed of different wavelengths λ_1, λ_2, λ_3 and λ_4 is directed from the optical input port [312] 340 to a collimator lens 314. The WDM signal traverses substrate 308 and is received by thin film filter 301. According to the characteristics of the thin film filter 301, the optical component with wavelength λ_1 is transmitted through the thin film filter 301, while the other wavelength components are reflected and directed to thin film filter 302 via substrate 308. The wavelength component λ_1, which is transmitted through the thin film filter 301, is converged by the collimating lens [321_1] 321 onto the tiltable mirror 315. Tiltable mirror 315 is positioned so that wavelength component λ_1 is reflected from the mirror to a selected one of the output ports 340_1-340_n via thin film filters 302-304, which all reflect wavelength component λ_1. The particular output port that is selected to receive the wavelength component will determine the particular orientation of the mirror 315.

[0045] As mentioned, the remaining wavelength components λ_2, λ_3, and λ_4 are reflected by thin film filter 301 through lens [321_2] 321 back into substrate 308 and directed to thin film filter 302. Wavelength component λ_2 is transmitted through thin film filter 302 and lens [322_1] 322 and directed to a selected output port by tiltable mirror 316 via thin film filters 303-304, which all reflect wavelength component λ_2. Similarly, all other wavelength components are

separated in sequence by the thin film filters 303-304 and subsequently directed by tiltable mirrors 317-318 to selected output ports. By appropriate actuation of the tiltable mirrors, each wavelength component can be directed to an output port that is selected independently of all other wavelength components.